Comparison of Emissions Benefits of CARB Diesel vs Federal Diesel

April 10, 2008

California Environmental Protection Agency

Air Resources Board

Agenda

Background
- •AB679 (Calderon)
- •Legislative Intent

- Test Schedule
- Funding
- Proposed Test Engine Selection
- Proposed Test Vehicle Selection
- Proposed Test Cycle Selection
- Fuel Properties
  - •Federal ULSD
  - •CARB ULSD
  - •Unified Modal Results
- Future Discussion Topics
- Next Meeting

Background

- Assembly Bill 679 (Calderon)
  - Requires ARB to convene a technical advisory panel to develop a test protocol
  - Test program shall measure the emissions benefits of CARB diesel fuel
  - Conduct test program
  - Report the results to the Senate Committee on Environmental Quality, the Senate Committee on Transportation and Housing, and the Assembly Committee on Transportation

Background

- Legislative Intent
  - Federal ultralow may produce emissions benefits closer to those of CARB diesel
  - Thought to be especially significant for HD diesel engines employing new technology (e.g. EGR)
  - Higher cost of CARB diesel is a competitive disadvantage for CA trucking industry
  - Develop and implement test protocol to measure differences in NOx & PM emissions between CARB diesel and Federal ultralow diesel

Test Schedule

- Emissions Testing – Scheduled to begin in Fall 2008
  - Test protocol development
    - Technical advisory panel, stakeholders
    - Currently soliciting input
    - Draft test protocol – in progress
    - Coordinating schedules with Biodiesel Research Program

Funding

- Test program currently funded for $1M
  - Proposed scope:
    - Engine dyno – 3 test engines, multiple test cycles
    - Chassis dyno – 12 to 15 test vehicles, multiple test cycles
    - Fuels – 1 ‘representative’ CARB diesel, 2 Federal diesel ‘blends’
    - Emissions measurements – THC, NMHC, CO, CO2, NOx, PM
- Currently, no additional funding is available to expand scope
  - Additional test engines/vehicles, gas-phase toxic HC's, carbonyl compounds, polycyclic aromatic hydrocarbons, elemental and organic carbon and size-resolved PM

Proposed Test Engine Selection - Engine Dynamometer Testing

- Test Engine 1
  - 2006 Cummins M11, 10.8 liter
  - EFN: 6CEXH0661MAT
- Test Engine 2
  - 1991 DDC Series 60, 11.1 liter
  - EFN: MDD11.1FZAZ
- Test Engine 3
  - 2007 Engine, to be determined
  - Possibly DD15

Proposed Test Vehicle Selection - Chassis Dynamometer Testing

- Propose testing a matrix of 12 – 15 vehicles
  - Matrix should be based on CA's in-use HD on-road fleet
  - Should incorporate a range of technologies if possible
  - Final matrix to be determined
- Vehicle acquisition
  - Advertisement
  - Rental / lease
  - Private owners
- Resources available for vehicle recruitment

Proposed Test Cycle Selection

- Propose using 'Translated' test cycle developed as part of the Biodiesel Research Program
  - Would allow comparison of engine dyno results with chassis dyno testing
  - Engine dyno results could be confirmed by chassis testing of in-use HD fleet
- Proposed Engine Dynamometer Test Cycles
  - FTP Transient
  - ARB Highway
- Proposed Chassis Dynamometer Test Cycles
  - UDDS
  - ARB HHDDT

Federal Diesel Fuel Properties

"Alliance of Automobile Manufacturers' North American Fuel Survey"
Summary Statistics for Selected Properties from the Winter 2007 & Summer 2007 Surveys
Note: Statistics are based on data from 18 U.S. cities, including Los Angles

#2 Regular Diesel S15	2007 Winter[1]			2007 Summer[2]		
	min	avg	max	min	avg	max
Rel Density (60/60° F)	0.8217	0.8461	0.8625	0.8169	0.8463	0.8602
T50 (°F)	442	500	551	452	504	548
Aromatics (v/v)	16.8	28.7	38.9	12.1	27.5	40.0
Cetane Number	41.1	42.8	46.7	40.2	46.9	56.6
Sulfur[3] (ppm)	1	6	12	1	6	17

[1] Samples taken in January 2007
[2] Samples taken in July 2007
[3] Using ASTM D5453 on S15 samples only

CARB Diesel Fuel Properties

Average Pool Properties[1]: Summer 2006[2]

Property	CARB ULSD
API Gravity	38.5
Rel Density (60/60° F)	0.8324
T50 (°F)	479.3
Aromatics (v/v)	17.6
Cetane Number (additized)	51.3
Cetane Number (clear)	49.1
Sulfur (ppm)	4.4

[1] All data represent volume weighted averages.

[2] Summer 2006: Refers to the period from June 1 through September 20, 2006.

Comparison of CARB and Federal Diesel Fuel Properties

Volume Weighted Summer 2006 vs. Average Sampled Summer 2007

Properties	CARB ULSD Volume weighted, Summer 2006	FED ULSD[1] Average, Summer 2007
Rel Density (60/60° F)	0.8324	0.8463
T50 (°F)	479.3	504
Aromatics (v/v)	17.6	27.5
Cetane Number[2] (additized)	51.3	46.9
Sulfur (ppm)	4.4	6

[1] Data from **"Alliance of Automobile Manufacturers' North American Fuel Survey"**

[2] **Assumes FED ULSD samples are additized**

Results from EPA's Unified Model

CARB ULSD, Average Summer 2006 vs. Federal ULSD, Average Summer 2007

EPA's Unified Model Results	Default NOx Represents All Engines (g/bhp-hr)	Group L NOx Represents EGR Engines (g/bhp-hr)	Default PM Represents All Engines (g/bhp-hr)
Federal ULSD	4.787	2.524	0.149
CARB ULSD	4.578	2.435	0.140
Emission Change	**- 4.4%**	**- 3.5%**	**- 6.0%**

Future Discussion Topics

- Additional data and analysis needed regarding range of fuel properties from commercially available Federal ultralow diesel fuel
- Determine vehicle/engine matrix for emissions testing
- Selection of appropriate Test cycle(s)
- Schedule coordination with Biodiesel research project

Next Meeting

- Tentatively scheduled for May, 2008
- Visit our web site
  - http://www.arb.ca.gov/fuels/diesel/dieselcomp/dieselcomp.htm

Contact Information

- Gary Yee, Manager
  - (916) 327-5986
  - gyee@arb.ca.gov
- Dean Bloudoff, Staff
  - (916) 322-1521
  - dbloudof@arb.ca.gov